THE INTERPRETATION OF X-RAY PICTURES AS AN AID TO THE EARLY DIAGNOSIS OF THORACIC ANEURYSM.

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Of all the accusing ghosts of the medical conscience, aneurysm claims a place well toward the front rank. This stricture is based upon the evidence that: (1) The condition is frequent;[1] (2) the diagnosis is seldom made until the disease is practically unmanageable; (3) the condition is preventable; (4) it is curable; and (5) the chance of cure diminishes very fast as the size of the tumor increases.

Even in this day of diagnostic dexterity it is not an uncommon occurrence for medical men, who may be admirably skilled in most directions, to carry on their visiting lists patients who are steadily going to ground with unrecognized aneurysm. The cough excited by the condition is not infrequently misinterpreted, and practitioners in Colorado sometimes find such patients to have been sent hither because of a supposed affection of the lungs.

It is not intended to give here a *resume* of the symptomatology of aneurysm. No one can deny that the student whose conception of the condition is founded solely upon the classical description of the disorder will rarely make a correct diagnosis until the anomaly has reached proportions which menace life itself.

Professor Osler[2] has recently summarized his vast experience in this field and fixed upon the subjective symptom of pain as the earliest common manifestation of aneurysm. We venture to follow the chain of events a little farther back and fix upon the signs of local increased intrathoracic pressure as the earliest recognizable evidence of aneurysm. This pressure may cause no abnormal sensation; it may be manifested only by unusual dyspnœa with muscular exertion; it often, by partial occlusion of a bronchus, diminishes the intensity of voice and breath sounds in a lobe of the lung without modification of percussion resonance; it so commonly irritates laryngeal nerve branches that any interference with the normal mobility of the vocal cords, or even a cough which is not explainable by obvious causes, should lead at once to the suspicion of unphysiological intrathoracic pressure.

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[1] According to the United States Census Bulletin, the number of deaths from aneurysm in the United States in 1900 was 754, being 0.8 in 1000 deaths. In 1890 the rate per 1000 was 0.6. The only vital statistics of Denver which are definitely appropriate to this subject are recorded for the years 1895 to 1898, inclusive. During this period there were noted 13 deaths from aneurysm, including 1 from "aortic disease." This gives a ratio of over 1.86 deaths from aneurysm to 1000 deaths from all causes in Denver for the four years. Whether this larger proportion is due to greater diagnostic acumen on the part of our medical fraternity, or to climatic conditions, or to habits which superinduce the pathological state, is not clear. It seems probable that the number of deaths ascribed to aortic aneurysm is everywhere below the truth.

[2] Medical Chronicle, Abst. in Med. Rev. of Reviews, Oct. 25, 1906.

From the considerable list of causes that may lead to such abnormal pressure, the selection of aneurysm can only be made after further analysis. It cannot be too impressively stated that aortic aneurysms of considerable size may be completely latent as regards the production of signs and symptoms which are usually held to be necessary for diagnosis. And yet we venture to assert that should the medical observer bring into this field but a fraction of the technique, judgment, and intuition he employs in the study of abdominal disorders, aneurysms would usually be discovered in their incipiency.

The first essential to the early diagnosis of aortic dilatation is a psychological state. The observer must never forget the possibility of aneurysm being a cause of symptoms emanating from the chest; and when there is a suspicion of syphilis in the history of the patient, we believe with Saathoff[3] that rigid inquiry should be instituted to exclude arterial degeneration. It is rare indeed that the patient, seen early in his disease, presents signs of aneurysm distinctive from those of pressure that may be caused by a solid tumor mass. The Röntgen rays, the skiagram, which should be tested by the fluoroscopic findings, should be directed to every case of doubtful nature. But to the beginner in the study of Röntgen pictures the chances of error in diagnosis are thereby profoundly increased. The interpretation of such images by the untrained eye is about as reliable as would be inferences founded on the sounds heard through a stethoscope by an untrained ear. Sailer and Pfahler,[4] in a valuable contribution, say, "The investigators who employed the fluoroscope or skiagrams for the purpose of studying changes in the aorta were early impressed with the fact that, although aneurysm was occasionally overlooked, it was more frequently diagnosticated when it did not exist."

The chief inherent difficulty in the interpretation of the skiagram probably depends upon the fact that the shadows give little or no perception of depth. The observer must learn to draw inferences from two dimensions only without artificial device to simulate perspective. Probably every clinician who has sought the aid of the Röntgen rays in his diagnosis can recall examples of errors of judgment immeasurably increased by misinterpretation of the pictures. Such an instance has already been reported by one of us.[5] It may be useful to recount another case or two occurring in the practice of the same observer:

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[3] Das Aorten-aneurysma auf syphilitischer Gründlage und seine Frühdiagnose. Münch. med. Woch., liii, Nr. 42. Abst. in Jour. Amer. Med. Assoc., 1906, 46, 2129.

[4] Tortuosity of the Aorta, Amer. Jour. Med. Sci., Oct., 1903.

[5] Sewall, An Extraordinary Case of Anthracosis Simulating Aortic Aneurysm, Amer. Jour. Med. Sci., Jan., 1906.

CASE I.—A man, aged thirty-seven years, a smelter hand, for the last two months of his active life was employed in a smelter for mercurial ores. He positively denied venereal infection. His height was considerably over 6 feet, and his weight in health 240 pounds. Signs of slight mercurialization appeared while in his last position; his physician declared that mercury had settled in his liver and caused enlargement. His complaint was of extreme weakness. Feet and legs became swollen, and he suffered from shortness of breath. He manifested orthopnœa for two months previous to entering the Denver County Hospital, October, 1904. He had lost about 20 to 40 pounds in weight in six months. On examination the patient appeared to be in good general condition; his only complaint was of dyspnœa, especially marked with exertion. There were the physical signs of double hydrothorax, the effusion being larger on the left side. The heart sounds were practically normal, but very faint and distant. There was no "Broadbent sign" of pericardial adhesion. Each pleural cavity was tapped at intervals and clear serum was withdrawn; not more than about one quart could be obtained at one sitting. The negative character of the patient's history and the lack of positive disorder in his heart and kidneys made him a subject of especial interest. It was concluded that his hydrothorax depended upon pressure on veins entering the heart and that the cause of obstruction was probably a mediastinal growth. On one occasion a trocar, inserted into the chest near the left posterior axillary line, about an inch above the angle of the scapula, when it had penetrated less than three inches struck against what was apparently a hard, solid object. Here, then, there appeared to be proof positive of a new-growth within the chest. The patient was well enough to go to the office of Dr. G. H. Stover, one of the radiographers to the hospital, for *x*-ray examination. The skiagram showed a dark shadow rising from the surface of the fluid remaining in the left pleural cavity, apparently just in the situation it should have occupied if caused by a mass as located by the trocar. The diagnosis of a solid growth, probably of mediastinal sarcoma, was now considered settled. In the course of two or three months the patient died under other medical care, and an autopsy was obtained. The postmortem examination failed to reveal anything in the nature of a tumor. The left pleura had become adherent throughout and had a thickness of about one-quarter inch. The "solid body" struck by the trocar during attempt at paracentesis was undoubtedly the sheet of pleura which had been pushed before the point of the instrument until its resistance became palpable. The pericardium was very thick and densely adherent all over the heart. The clinical history and the fatal ending are easily explained by the postmortem findings.

Case II.—A man, twenty-eight years of age, came to Denver on account of faintly marked tuberculous infiltration at the apices of his lungs. Syphilis was denied. After a sojourn of a month it was evident that a fresh invasion of the pleura covering the upper lobe of the left lung had occurred, the morbid signs being especially marked along the left sternal border. At the same time a pulsation synchronous with the heart beat, and having an outward systolic excursion, appeared in the first left intercostal space within an inch of the sternum; there also developed a slight but distinct tracheal tug. A skiagram of the patient's chest, the plate having been placed on the back, showed a well-marked shadow above the heart, left of the vertebral column, as if made by a considerable dilatation of the descending aorta. Seen through the fluoroscope, the outlines of the shadow pulsated with the heart beat. The dimensions of the image were considerably less in a skiagram obtained with the sensitive plate situated on the front of the chest; the object in question was, therefore, nearer the anterior than the posterior wall of the thorax. When the abnormal shadow was viewed through the fluoroscope it diminished in diameter and practically disappeared when the patient, in the upright position, turned his body so that the rays penetrating the thorax should cut at a certain angle the anteroposterior plane. The interpretation of the shadow then became clear; it was simply due to the opacity of the pleura of the left lung, seen in optical section, bounding the anterior mediastinum. When the incident rays fell obliquely upon the sheet of thickened tissue the shadow was broad; when the rays were parallel to the membrane the shadow narrowed. The various pulsations and the tracheal twitch were also easily explained as the result of pleuropericardial adhesions.[6]

Lest the use of the Röntgen rays should seem to introduce more difficulties in diagnosis than it dissolves, it may be well to cite two more cases in which the radiographic pictures proved of vital therapeutic assistance:

Case III.—A gentleman, aged forty-seven years, who had had syphilis in his youth, was an active business man, carrying great responsibilities. His weight was about 240 pounds, his musculature rather flabby. He smoked to excess and took several drinks of strong spirits after office hours. He developed a dry, hacking cough, which was exaggerated with excitement or exertion. Physical examination of the patient revealed nothing noteworthy, except a diminution in the intensity of the respiratory murmur, voice sounds, and tactile fremitus at the left apex, while the percussion resonance was unchanged. An *x*-ray picture of the chest revealed a slight but obvious bulging of the aortic arch upward and to each side. The patient was cut off from his liquor, his indulgence in tobacco was limited, his physical exertions were greatly reduced, his diet was lightened, and iodides were administered in small doses. In a few days improvement was manifest and before long all morbid symptoms disappeared. Another *x*-ray picture taken some eight months after the first showed a much more normal aortic shadow.

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[6] In an essay by one of us (Sewall, Some Conditions Other than Aortic Aneurysm which Determine the Occurrence of the Tracheal Tug, Trans. Assoc. Amer. Phys., 1901, xvi) it was pointed out that pleural adhesions of the left apex were prone to give rise to a slight "tracheal tug." The case cited above would indicate that adhesions involving the mediastinal pleuræ would tend to produce the same phenomenon.

CASE IV.—A lady, aged fifty-five years, suffering from chronic pulmonary tuberculosis marked by very slight infiltration of the left apex, but by a dry cavity at the right apex, suddenly developed a dry, spasmodic cough and hoarseness with use of the voice, and there appeared a marked pulsation, synchronous with the heart beat, in the first left costal interspace, about one inch from the sternum, and in this area there was a marked systolic bruit. The larynx was normal except that the left vocal cord was found partially paralyzed and in nearly the cadaveric position. This patient gave a history of having had five miscarriages. Moreover, for ten days preceding the sudden development of the symptoms described she had rested, for a purpose that need not be described here, with the foot of her bed elevated about seven inches above the floor. The skiagram showed slight globular enlargement of the extremity of the aortic arch with extension upward, a condition which without the clinical symptoms could readily be ascribed to simple "tortuosity" of the aorta. But when we consider the suspicion of luetic infection aroused by the history of five miscarriages there is ground for assuming arterial degeneration. Again, Stephens[7] has found that the maximal arterial blood pressure is very much increased in the "head down" position. In a study of 22 healthy young men Dr. Stephens found the means of his estimation of blood pressure, measured in the left arm, to be, standing, 130 mm. Hg.; sitting, 130; supine, 148.3; head down (body at an angle of 45 degrees) 165; right lateral, 114; left lateral, 156; It is not now necessary to consider the discrepancies between these results and those found by other observers, notably by Erlanger and Hooker[8] in their admirable treatise.

If Stephens' conclusions be true, we have an explanation of the sudden development of pressure symptoms; for nothing is more common in the history of aortic aneurysm than the sudden development of symptoms following exertions that raise arterial pressure. Moreover, the skiagram of this patient showed a marked enlargement and density of the bronchial glands, the presence of which could easily have opposed to the aorta a counter-resistance capable of generating pressure symptoms which would otherwise be wanting.[9] It may be said that during a rest in bed for nearly five months all symptoms attributable to aneurysm gradually disappeared.

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[7] Blood Pressure and Pulse Rate as Influenced by Different Positions of the Body, Jour. Amer. Med. Assoc., Oct. 1, 1904.

[8] An Experimental Study of Blood Pressure and of Pulse Pressure in Man, Johns Hopkins Hospital Reports, vol. xii, 1904.

When it was first discovered that the body could be made transparent, the Röntgen rays were supposed, necessarily, to offer a plain revelation of every anatomical secret. When it was found that mistakes in diagnosis might be multiplied and intensified by the general application of the method, there was a widespread reaction of discouragement as to its value. There is evidently still need of general information as to the limitations and conditions of usefulness of the *x*-rays in diagnosis.

We have been so strongly impressed with the difficulties of correctly interpreting the shadows of the thoracic skiagram that we venture to believe that a categorical summarization of the elements of confusion that have developed in our experience may be of service to beginners in this important field of diagnosis, when the *x*-rays are employed to ascertain whether thoracic aneurysm exists. Our conclusions are similar to those of Baetjer,[10] whose valuable paper was not seen until our work was finished:

1. In the study of fluoroscopic and skiagraphic pictures the beginner is apt to forget the fundamental importance of centring the rays and maintaining them as nearly as possible perpendicular to the plate or screen. Even when anode and screen or plate are so far separated that the incident rays are approximately parallel, a slight inclination of the receiving surface distorts the outline of the image, just as an object on the ground throws a distorted shadow in the light of the setting sun. No proper comparison can be made of the opposite borders of a Röntgen shadow unless the corresponding rays fall upon the sensitive plate at the same angle. Very gross errors as to the size and shape of the objects within the chest, as, for example, the mediastinal pleura or the arch of the aorta, may arise from failure to dwell upon this physical fact.

In a skiagram obtained with the central rays perpendicular to the chest at the lower border of the manubrium, the plate being at the back of the subject and the tube at least twenty inches from the plate, the top of the normal aortic arch should appear to be about opposite the fourth costal interspace behind.

2. It must never be forgotten that the *x*-ray picture usually

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[9] One of us has notes on two other cases, one having come to autopsy, in which extraordinary clinical symptoms, notably paroxysmal vomiting, seem properly to be ascribed to irritation of vagus nerve branches pinched between an intermittently dilated aorta and a much enlarged bronchial gland. Dr. Robert Levy, of Denver, whose laryngological observation of tuberculous persons has been very extensive, in a personal communication states that some five or six cases of laryngeal paralysis, due apparently to pressure upon a recurrent laryngeal nerve, have come under his care. The disorder usually involves the left vocal cord. In two patients, at least, the function has been restored. The paralysis was ascribed to the pressure of enlarged bronchial glands; such bodies were prominent in skiagrams taken in two cases.

[10] X-rays in the Diagnosis of Aortic Aneurysms, Johns Hopkins Hosp. Bull., January, 1906.

forms but one link in the diagnostic chain. The significance of the skiagraphic findings can often only be inferred after careful consideration of the clinical history, signs, and symptoms furnished by the patient. A wide range of anomalies of the thoracic aorta and its branches is to be found in the literature. Moreover, a condition well described by Sailer and Pfahler as "Tortuosity of the Aorta" is so commonly found in healthy subjects, as well as those manifesting vascular senile changes, that it must always be eliminated in considering the significance of a broadened shadow of the aortic arch. These authors point out that, especially in atheromatous subjects, the aortic arch may be elongated and its unsupported parts may be considerably displaced, as is so frequently seen in the peripheral arteries in conditions affecting their elasticity. The clinical determination of atheroma of the aorta is not without difficulty.

As pointed out by Klotz,[11] arteriosclerosis is apt to invade by preference vessels in the parts which are most used. It has been held that hypertrophy of the heart accompanies sclerosis of the aorta, but not sclerosis which involves peripheral arteries alone. The "tortuosity" of the aorta gives a skiagraphic picture which might easily be mistaken for aneurysm. But, owing to the topographical relations of the aorta, it is more common for the bulge in the shadow to occur to the left, at the descending part of the arch, than to the right. But, unless there is a true dilatation of the vessel, the image of the transverse portion of the arch is not likely to rise above its normal position. Our own experience has been chiefly with younger subjects than those studied by Sailer and Pfahler, but it confirms their contention that spurious bulging of the aortic shadow, particularly at the descending part of the arch, is a common phenomenon, and that it is especially likely to be found where arterial elasticity is diminished. We have not tested the matter thoroughly, but we venture to think that the fluoroscopic study of the patient while, in the sitting position, he turns round a vertical axis, should aid in the discrimination of elongation from dilatation of the aorta; with mere elongation of the artery the bulging of the arch should diminish when the rays become more nearly parallel to the plane of the arch. The conditions of the observation are, however, rather complex, and each case must be judged by itself. In our experience, bulging of the shadow to the right of the vertebral column is much more indicative of a pathological condition than an extension to the left. Extension of the aortic shadow upward, especially if associated with a bulge to the right, is very suspicious of a pathological condition.

3. Dilatations of the aortic arch, particularly in its ascending limb, are of frequent occurrence and must always be discounted in

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[11] The Relations of Experimental Arterial Disease in Animals to Arteriosclerosis in Man, Jour. Exper. Med., Aug. 1, 1906, p. 504.

the subjects of atheromatous vessels. It is of the highest importance, from a clinical point of view, to determine whether such dilatations are potential aneurysms, In our opinion, a history of syphilis in such a patient is sufficient ground to justify the medical observer in instituting treatment appropriate to the cure of aneurysm, as already advised by Saathof. Nevertheless, here, too, physical and circumstantial evidences may apparently conspire in leading the observer to wrong conclusions, as witnessed by the following case:

CASE V.—Mr. G., aged twenty-six years, twelve years ago contracted syphilis, for which he was treated for about two years. He has had pulmonary tuberculosis about five years. For three years he has suffered much from chilly feelings in springtime. No history of malaria. Physical examination: Weight, 117 pounds. Wheezing rales throughout lungs, especially in right upper lobe, where there are obscure cavernous signs above and below clavicle. Air enters lower right lobe poorly. The apex beat is in fifth space under the nipple, but also faintly felt in sixth space, parasternal line. The area of "aortic dulness" is much enlarged, including the upper sternum and an area more than an inch broad on each side of it. The aortic second sound is somewhat accentuated. There is a slight tracheal tug. In the second right interspace, under the middle of the clavicle and to the right of the aortic dulness, is a pulsation outward in systole, both palpable and visible. In the second left interspace, close to the sternal margin, is a very small area of pulsation inward at systole. The veins of upper extremities are somewhat prominent, esoecially those of right arm and upper right chest. The abdominal veins are prominent in the erect position. There is noticeable epigastric pulsation, which is outward in systole on left border of epigastrium. There is very slight outward systolic heave of upper right chest. Lying supine, there is considerable pulsation above the clavicle, but nothing can be felt. There are no bruits; the radial arteries are slightly thickened. The pupils are equal and the pulses of even volume. There is no chest pain or significant cough.

When viewed by the Röntgen rays this man's chest presented typical difficulties in interpretation. The aortic arch was slightly higher than usual, and there was a perceptible outward bulge to its descending portion. Opposite this point, in a position corresponding to the ascending aorta, the shadow broadened in exact imitation of a dilatation of the artery. A dense band of tissue passed from the heart base, tangent to the apparent aortic shadow, upward and outward, to be lost in the apex of the right lung. Through the fluoroscope this band was seen to have a plain respiratory excursion, and it bounded the lower border of a small tuberculous cavity under the right clavicle. The pulsation in the second right interspace probably had its origin in adhesions of this band. Two skiagrams and a fluoroscopic study of these relations convinced us that the apparent dilatation of the ascending aorta, in spite of the clinical signs suggesting it, was spurious and due to tuberculous infiltration and distortion of the right mediastinal pleura and adjacent structures. Incidentally, the skiagram revealed a well-developed cervical rib on the right and a rudimentary one on the left of the patient's neck.

When repeated skiagraphic studies of a doubtful case through long intervals of time becomes a routine practice, disaster to patients from the insidious development of arterial degeneration will doubtless often be averted.

4. Relatively little notice is given by technical writers on this subject to confusion arising from the configuration of the bronchi and pulmonary bloodvessels. The shadows of these channels are often lost in the development of the plate. In a skiagram taken as described above, the bronchial tree and pulmonary artery in each lung are commonly represented by a single, short, horizontal trunk projecting from the spinal shadow on each side at about the level of the seventh dorsal vertebra, and dividing at a distance of about two inches from the middle line into two branches, one of which ascends parallel to the spinal column and the other descends in a direction somewhat obliquely outward.

Radiographers seem not to be in accord in the interpretation of these shadows.[12] Some take them to be the outlines of the bronchial tubes, while others hold that they represent the pulmonic arteries. Theoretically, it ought to be easy to distinguish the shadows of an air-filled tube and a blood-distended vessel; the one should increase in density toward the middle and the other on the margins. In the subjects of peribronchial sclerosis and adenitis the bronchial tree undoubtedly forms the basis for a considerable part of the figures in question. Enlargement, calcification, or pigmentation of the groups of lymph nodes at and near the bifurcation of the trachea is pretty sure to be represented in the trunk of the bronchial tree springing from the spine at the level of the seventh dorsal vertebra.

In normal lungs without undue development of connective tissue or enlargement of the lymph nodes, it is improbable that the course of the dividing bronchial tubes is to be traced in the radiogram. But it can easily be proved that figures corresponding in position to the outlines of the "bronchial tree" can be developed at will by overfilling the pulmonary bloodvessels. Our demonstration of this fact was founded upon and modified from an ingenious experiment of Professors Zuntz and Loewy and their collaborators,[13] who studied the changes in heart volume under extreme differences in the phases of respiration. Our purpose was to compare the skiagrams of a normal chest taken (1) when emptied as thoroughly as possible of blood; (2) when congested as fully as might be. In the first case the subject, an adult male with spare figure and normal lungs, at the end of an ordinary expiration, closed the mouth and nostrils and then strongly contracted all the muscles of expiration during the period of exposure. In the second case the subject, at the end of an ordinary expiration, closed mouth and nose and then attempted to draw air into the lungs by contracting the muscles of inspiration. The relative anemia or congestion of the lungs was additionally furthered by taking the skiagrams with the subject supine, in the first case with the body inclined, head up, at an angle of about 12 degrees to the horizontal, and in the second case with the head down at the same inclination.

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[12] P. M. Hickey, The Interpretation of Radiographs of the Chest (and discussion), Trans. Amer. Röntgen Ray Society, 1905, p. 136.

[13] Hohenklima u. Bergwanderungen, 1906, S. 352.

Detailed description of the pictures so obtained will be given in another place, but it is pertinent to state here that the skiagram of the congested lungs shows well-marked figures corresponding to the ramifications of the "bronchial tree" which are absent from the companion plate.

When the system of peribronchial glands is well developed, particularly if there is a condition of pneumonokoniosis, the outlines of the bronchial tree, with the attendant arteries, can lead to error, particularly through the simulation of an aneurysm of the descending aorta by the tubes supplying the lower lobes of the lung.

5. In any disorder of the lungs attended by sclerosis, as is so often witnessed in pulmonary tuberculosis, the heart is likely to be drawn far out of its normal position. We have especially noticed that displacement of the heart to the right tends to develop a perceptible tracheal tug. The shadow of the displaced heart made by the x-rays may lead to confusion as to the meaning of the images about it. In such cases there is likely to be a greatly thickened pleura and enlargement of the bronchial glands, which combine to broaden the shadow from the base of the heart upward.

6. A tumor of the œsophagus could with difficulty, if at all, be skiagraphically differentiated from a saccular swelling of the aorta.

7. The mediastinal glands, particularly in tuberculous subjects, are a fruitful source of error in diagnosis. Moreover, the chains of infiltrated glands in the lower thorax can easily suggest a fusiform dilatation of the descending aorta. A group of enlarged glands at the aortic arch may, according to our observations, give a massive shadow, pulsatile under the fluoroscope, which it is exceedingly difficult to differentiate from an aneurysm. The medley of enlarged glands, thickened pleura, and cirrhotic tissue enclosing pulmonary cavities may cast a shadow almost exquisite in its imitation of aneurysmal dilatation. In such cases it is usually easy to avoid error by noting the homogeneity and regular outline of the aneurysmal shadow as compared with the unequal density of surface and more or

less knobbed outline of its spurious imitation. As already hinted, clinical experience has strongly impressed us with the suspicion that the presence of enlarged glands about the aortic arch is peculiarly likely to result in the manifestation of nerve-pressure symptoms, with very slight degrees of arterial dilatation. A nerve trunk might be widely displaced by a swelling artery without provoking signs of irritation; but if the sensory cord is pinched between the vessel wall and an unyielding body, such as an enlarged, hardened gland, the slightest abnormal dilatation of the artery might be expected to provoke profound sensory disturbances. Our experience indicates that certain cases of angina pectoris and of paroxysmal vomiting may have their origin in this way.

8. Pneumonokoniosis may lead to the precipitation of dense shadows throughout nearly the whole or any part of the thoracic skiagram, and can easily be so situated as to simulate saccular aneurysms. A mistake in diagnosis made by one of us in this direction has already been referred to.

9. The thickened pleura is remarkably opaque to the Röntgen rays. It is frequently the case, especially in the subjects of pulmonary tuberculosis, that in the development of the *x*-ray plate the image of the heart is completely obliterated before the shadow formed by the obscuring pleura can be dissolved, especially when the plate is placed at the back. An actual error in diagnosis, largely due to the conformation of a thickened pleura, has already been recorded above. We have been especially impressed with the importance of the mediastinal pleuræ as occasionally giving rise to suspicion of aneurysm of the descending aorta. The apparently expansile pulsation which the heart movement may give to these membranes is very suggestive of a vascular tumor. Before drawing conclusions from the radiographic pictures in respect to these sources of error, there should be a comparison of skiagrams obtained with the sensitive plate upon the front of the chest with that made in the usual manner. By reason of the divergence of the *x*-rays a given object will appear larger and less well defined the farther it is situated from the sensitive plate and the nearer it is to the source of the rays. It is particularly serviceable to analyze the fluoroscopic image by viewing it along different radii of a horizontal plane, as can be easily accomplished when the patient, sitting upright, turns his body on a vertical axis. By this means, for example, the dense shadow thrown by a pleural membrane when penetrated obliquely by the rays may be seen to contract its borders as the sheet of tissue is viewed edgewise.